Personalized Investigations

Teachers' Guide

Suggested Grades: 3-12

Objectives:

- Select instruments to make observations and/or organize observations of an event, object, or organism (S4-2), identify and/or discuss the selection of resources and tools used for exploring scientific phenomena (S4-7), demonstrate an understanding of the use of measuring devices and report data in appropriate units (S9-4), or demonstrate an understanding of units of measure and precision by using an appropriate measuring device for an application (S12-12).
- Evaluate observations and measurements made by other persons (S4-8).
- Demonstrate an understanding of safe use of materials and/or devices in science activities (S4-9), identify the potential hazards and/or precautions involved in scientific investigations (S6-2), or identify and apply science safety procedures (S9-3).
- Make inferences from observations of phenomena and/or events (S6-3).
- Evaluate conclusions based on scientific data (S6-5).
- Formulate an experimental design to test a given hypothesis (S12-8).

Strategies:

- Personalized research investigation is at the heart of TECH TREK. We encourage you and your students to develop your own plans for research in the laboratory. You could develop one large investigation with many parts over several days or one project per class or multiple projects, individualized to student interests. We are even willing to accommodate individual science fair investigations that require microscopy, although it would be impossible to prepare 50 or samples for individual investigations in one week!
- During training, you will learn what can be done with the equipment on TECH TREK. Discourage your students from investigations that require study of bacteria, viruses, DNA, or the interior components of cells. These are beyond our capability. For these types of investigations, students might work with specialists in local universities or hospitals.
- Develop a correspondence with the TECH TREK staff to review proposed investigations. Expect revisions to address practicality, safety, and design of experiments.
- If you plan to use the SEM to view specimens, provide time to dry them before we arrive. We cannot put wet or oily tissues in the Sputter Coater or the SEM.
- Design your experiment(s) to demonstrate the scientific method with testable hypotheses, controls, and techniques for measurement.
- Require students to research what is already known about their questions before finalizing their experimental design. Verifying somebody else's research is a valid scientific approach, but it's best to know what they did and what they found before beginning this kind of experiment.
- For more information about Science Fair projects, contact **The Ohio Academy of Science, 1500 West Third Ave., Suite 223, Columbus, OH 43212-2817, Phone or FAX (614) 488-2228.**
- When designing experiments, pick projects the kids care about! Involve them in all the facets of project development.

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Step One: Develop an interesting question.

- Review the introduction and purpose with the students.
- Make certain the students know that their questions should be kept "above the belt" and should only address issues that will not result in someone or something being hurt.
- After giving students the opportunity to propose possible questions and experiments, play the Science Game.

Step Two: Play the Science Game.

- Prepare your answer key in the teacher's guide.
- One way to play is similar to "Who Wants to Be a Millionaire?" Select someone to be the first contestant. Encourage the other students to play along at their seats. Have several rewards ready for those who claim to have won a Million Dollars. Allow the contestant(s) to use the three lifelines (Phone a Friend, Ask the Audience, and Fifty-Fifty). As the contestant answers questions, the dollar value goes up as follows: $100, $200, $300, $500, $1000, $2000, $4000, $8000, $16000, $32000, $64000, $125,000, $250,000, $500,000, $1,000,000! On difficult questions, always ask, "Is that your final answer?" If the contestant misses a question, pick somebody new. I suggest you alternate boys and girls as contestants.
- Play and discuss the answers while you play. Extend some of the questions on science projects by asking the students to try to come up with another good example.

Step Three: Write a good hypothesis. As a class, review the qualities of a good hypothesis. Help them to create some examples. Assign the writing of several possible hypotheses related to their questions. Talk with students about their ideas and help them to make improvements.

Step Four: Develop a good experimental design. Pick a question or a hypothesis that you have used as an example before. As a class, develop a good experimental design. Do this again for another topic. Discuss common features, such as maintaining a control for comparison and trying to vary only one variable at a time (unless using DOX, a research methodology popularized in the Dayton region by John Sparks of WPAFB … that saves money by allowing more than one variable to be adjusted at a time). Have students work in groups to brainstorm and develop experimental designs for their personalized investigations. Review these with students and make suggestions. Science Fairs require special permission for experiments with drugs and controlled substances. Special permission is also required for experiments with any vertebrate animals. I assume this includes themselves and other humans.

Step Five: Experiment, but don't forget to write! Once their design has been approved, students should conduct their experiments. Remind them that they must have a method for recording their observations. At minimum, this means using a pencil and paper to take notes. A chart is often useful to record the results of repeated trials. “If it’s not written, it didn’t happen!”

Step Six: Present your findings! Humans, as a species, can communicate. This saves us time and energy because we can learn from others what might take us a lifetime to learn on our own. Students can present their findings on a traditional science fair board or on a poster, a report, a PowerPoint presentation, or a verbal report. Sharing their findings with the rest of the class helps their peers to practice evaluating the measurements and research of others in a less-threatening way, while helping the presenters understand their material more completely. For some students, presenting their findings might mean publication in their school paper or a scientific journal. Some of you might have students bring their projects to a science fair for further recognition.

- Some of your students, student groups, or classes may develop projects that will require investigation on TECH TREK, using our microscopes and/or computers. If there is enough need, the vehicle can be scheduled at your school. Otherwise, it may be possible to take a group of students to TECH TREK at another location during or after school hours.

- If you have a project of your own for TECH TREK, please begin correspondence with TECH TREK staff early via e-mail, fax, phone, or letter. You will want to let TECH TREK staff know your question, hypothesis, and experimental design. TECH TREK staff should review your plans and make suggestions for improvement. You should address these concerns and resubmit your requests until you can agree.

- As you probably know, the equipment currently on TECH TREK is well-suited for two main purposes:

1. Magnification (enlargement) to show detail not otherwise observable.
2. Computer management of data and information such as word processing, graphing analysis, and image enhancement.

- Please determine whether or not you are going to need the equipment before you ask TECH TREK to visit your school.

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Student Guide

Step One: Play the Science Game.

Purpose: Play to learn what makes good science and measurement. Don't worry. Most of the questions are easy. Some are just common sense. But, stay awake! You might learn something! **Score:** Start with $100 and double for each correct answer or use class rules.

1. When measuring in the metric system, the prefix **centi-** represents …
   A. One century B. One cent C. One hundred D. One-hundredth

2. Which is better science?
   A. You eat peanut butter and say you like it!
   B. You compare peanut butter with apple butter and say you like P.B. better!
   C. You have two people compare peanut butter with apple butter and you record their responses.
   D. You have fifty people compare peanut butter with apple butter and you record their responses.

3. Which is the better way to improve the recipe for a cake?
   A. Add more eggs and taste if it's better. B. Add more oil and taste if it's better.
   C. Add more eggs and less oil. D. Change one ingredient at a time and compare the results from each batch.

4. Use your ruler to estimate the length of your pinkie finger. Is it…?
   A. 5 mm B. 5 cm C. 5 in D. 5 ft

5. When measuring in the metric system, **mm** stands for …
   A. millimeters B. million man C. micrometers D. chocolate candy

6. When measuring in the metric system, **kg** stands for …
   A. Kellogg's B. Kilometers C. Kilograms D. Kringle's

7. To get students' interest in a class project, the teachers should…
   A. Get releases from parents.
   B. Ask kids for ideas, but do the experiments themselves.
   C. Involve the students in all aspects of planning and doing the experiment.
   D. Gather supplies for the experiment, but let kids do the experiment.

8. Which is the best way to start designing a science experiment?
   A. Teacher tells you what to study. B. Scientist tells you what to study.
   C. Your mother tells you what to study. D. You choose something you'd like to do.

9. When measuring in the metric system, the prefix **milli-** represents …
A. One million B. One-millionth C. One thousand D. One-thousandth

10. When measuring in the metric system, the prefix **micro-** represents …
A. Too small B. Too big C. One-millionth D. One million

11. Which of these represents the smallest unit of length?
A. nanometer B. micrometer C. millimeter D. centimeter

12. Use your ruler to measure the width of your pencil. Is it … ?
A. O.7 mm B. 7 mm C. 70 mm D. 7 cm

13. Imagine you are preparing 12 slides for the scanning electron microscope (SEM). What is the most important thing you should do for an accurate experiment?
A. Label the slides! B. Get finished before the bell rings!
C. Give the slides to the teacher! D. Clean up your area!

14. Which of these is the best science project question?
A. If I eat half a pizza, how much will be left?
B. What do worms look like after they have been stepped on?
C. What is the effect of Pantene Pro-V spray on hair?
D. Are there blood cells in arteries and veins?

15. Which of these is the best-written hypothesis for a science project?
A. How does switching to Premium gas affect my gas mileage?
B. There were more fatalities because of drunk driving last year than from combat fatalities during the entire Vietnam War.
C. If I eat too many beans, I will get a stomachache.
D. In a double-blind taste test, more people will prefer Coke over Pepsi.

16. Why would it not be a good idea to test the effect of caffeine on typing speed for a science project?
A. Caffeine does not affect reaction time. B. Caffeine could be considered a drug.
C. How can anyone measure typing speed? D. It would cost too much for caffeine.

17. Which of these science projects might require special permission before starting experimentation?
A. Studying the effects of music on plant growth.
B. Comparing various laundry soaps.
C. Researching the favorite foods of 6th-graders or guinea pigs.
D. Researching the effects of music on ants.

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Step Two: Develop an interesting question.

Introduction: Everybody does science in one way or another. *You try putting a new outfit together and you watch the reactions of your friends to see whether they like it. The ice cream store creates new flavors and asks their customers to tell them how they taste. TV Networks count how many people watch prime time shows and keep the best ones. If companies do good research, they will know what to buy and sell and make more money. If you watch your friends' reactions carefully, you will be better able to gauge what's cool and what's not.* We are going to do some science research together. We can learn more when we do science if we first make an effort to design our experiments well.

Purpose: You will think of some questions that you'd like to know more about. You will write some of these on paper. You will then write about some ideas you have on how you could investigate the answers to these questions.

Questions worth thinking about:

1.

2.

3.

4.

5.

Experimental Design: What science experiment(s) could you do to learn more about the answers to your questions?

1.

2.

3.

4.

5.

6.

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Step Three: Write a good hypothesis

What are the qualities of a good hypothesis?

Choose your best and most interesting question from Step Two. Does you question have these qualities?

If your question does not have these qualities, can you alter it?

Write your hypothesis. Check with your teacher.

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Step Four: Experimental Design

Theme Question:

Hypothesis:

Procedure (Include sketches and a list of needed supplies and equipment.)

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Step Five: Experiment, but don't forget to write!

When you design your experiment, remember to design data collection, note taking and observations into your plan.

Step Seven: Present your findings!

Your presentation should contain:

- Hypothesis
- Experimental Procedures
- Observations
- Conclusion

Your presentation should be:

- Neat
- Visually pleasing
- Interesting
- Grammatically accurate
- Show a flow of thought
- Scientifically accurate

Possible presentation projects:

- Poster
- Multimedia presentation (Powerpoint, etc.)
- Report
- Verbal presentation with demonstration

Have fun with your presentation. Be able to explain your experiment and your conclusions. If you are able to demonstrate your experiment on site, be prepared to do so!